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has a very narrow elevated crest. This induced Lambe to call it the crowned saurian. The teeth have minute denticles along the margins in the front part of the jaws, which are not so pronounced in the back part. Quite a number of the bones of the skeleton were found with this specimen.

I was so fortunate as to find a fine skull of *Monoclonius nasicornis* Brown. My son Levi has beautifully restored it. It lay on the side of a steep slope, part of one side washed down the hill. However, when they were restored, very little was missing. It is the best specimen my parties found in the four years we collected there. It is 4½ feet long, and as far as I know, equalled only by the type in the American Museum, New York, where they have the entire skeleton. I have described these dinosaurs in my recent book, "Hunting Dinosaurs in the Red Deer River, Alberta, Canada," and need not go into details here.

In addition to the dinosaurs collected, I secured a large collection of scattered bones that will be of value as hand specimens to illustrate the wonderful fauna of the Pierre age.

We secured some fine turtles. Two, in fact, have nearly perfect shells. One, Lambe's *Boremys pluchra*, a new species, Levi found in 1913. The other is evidently new, and is the only one I have found in the Belly River Series, either in Montana or Canada, where the ribs are not coössified to the margin. It resembles somewhat the sea tortoises of the Niobrara chalk of Kansas. Then we have a beautifully sculptured plastron of a new species of *Aspiderites*, a form that was not covered with horny scutes, half the plastron of a large *Adocus* that must have been three feet long in life. This shows the marks of very strong horn plates.

Glacial Moraines in the Vicinity of Estes Park, Colorado.

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While spending his August vacation near Estes Park village, the writer unexpectedly penetrated a region of enormous glacial activity of prehistoric times. Having given years to the study of the moraines of Kansas, Wisconsin, Michigan, Illinois, Indiana and Ohio, belonging to the great continental glacier that once covered the northern United States from Dakota to Cape Cod, the writer became at once interested in these moraines of the alpine glaciers of the Rocky Mountains that formerly filled the upper valleys of the Thompson river and its tributaries.

The introduction to the moraines came when a party of relatives and friends laid a picnic luncheon in the Thompson river at the gateway to Moraine Park. Giant bowlders filled the river, so we were safe from a wetting. The river here falls in cascades one hundred feet through and over the terminal moraine of a glacier that formerly filled Moraine Park. This glacier undoubtedly received tributary ice rivers down Forest, Spruce and Fern canyons and was in its time a glacier of no mean dimensions. It pushed but two or three miles beyond the mouths of the canyons, for it encountered a great glacier from the southwest

and the two stopped in the narrow gap between Eagle Cliff and Giant-track mountains, and here left their front moraines. Later, when the Moraine Park glacier melted back to and up the canyons, the front and lateral moraines impounded the water from the melting ice and thus produced a lake two or three miles in length and nearly one mile in width.

Gradually this lake became filled with silt from the mountains and the moraines, slowly the outlet of the lake lowered its channel through the front moraine till in the course of time the green of dry land replaced the blue of the water, and Moraine Park was formed.

Students of Rock Mountain history will be interested in a bowlder which lies at the gateway to the park which shows that the present mountains were formed where ancient mountains had yielded to the pounding of the waves of an old-time ocean. This bowlder consists of rounded pebbles of granite, mica schist and beach sand, all fused into a compact rock, when the present mountains were crushed and folded and made into a mighty range during the Tertiary period.

On the north side of Moraine Park lies a moderately developed lateral moraine, but on the south side is the remarkable ridge of bowlders from which the park takes its name. At its middle part this moraine rises five hundred feet above the park floor on the north and four hundred feet above the valley of Mill creek on the south. From this middle point the moraine slopes endwise to the eastward till it dies down a short distance beyond the terminal moraine on the Thompson river. From its remarkable development and its straight course, this moraine must have been formed between two glaciers, and is therefore an interglacial moraine comparable with the interlobate moraines of the continental glacier of Wisconsin and eastward. It would be strange if there were not a ridge of gneiss in the axis of this moraine, but no rock in place was observed.

Still further south, between Mill creek and Glacier creek, is another moraine of similar character, but of more massive proportions. Its crest is a thousand feet higher than the crest of its companion interglacial moraine to the north, and it rises 650 feet above the valley of Glacier creek on the south. This interglacial moraine heads near Flat-top mountain and Hallett's peak, and extends in a northeasterly direction nearly to the Y. M. C. A. conference ground. It must have been formed from glaciers that flowed down Mill creek valley on the north and a powerful group of ice rivers on the south, which flowed out of Glacier gorge, Loch Vale and the Tyndall Glacier valley. The southern slope of the moraine is very abrupt and can be climbed by horses only by following a zigzag trail. The northern slope is more moderate and is heavily forested with pine, especially in the vicinity of Bierstadt lake and Bear lake.

Other moraines undoubtedly border the valleys in this heavily glaciated region north of the Long's peak group of mountains, but more time than the writer had at his disposal would be necessary to enable one to make a detailed description of them.

Four miles up Fall river from Estes Park village, a short distance beyond the fish hatchery, is the best developed terminal moraine seen in

the vicinity of Estes Park. Fall river tumbles in a series of cascades over the successive ridges of this moraine down a total distance of five hundred feet. In general appearance, these morainic ridges greatly resemble similar ridges in the bluffs south of Whitewater, Wis., belonging to the moraine of the Wisconsin glacier.

Beyond the terminal moraine of Fall river valley the melting glacier left a lake four miles long and half a mile wide. This in time became filled with sediment and is now Horseshoe park. On either side of the park are weak lateral moraines.

Perhaps the most unique glacial phenomena are shown in the valley of Roaring river, a small stream which joins Fall river from the north near the head of Horseshoe park. The glacier which plowed its way down Fall river valley carried a heavy body of ice, which cleaned out the valley from mountain to mountain on either side and cut very deep, so deep that Roaring river was left with its mouth two hundred feet above the level of the main stream, and is compelled to reach it down a series of waterfalls. Above these falls the river descends two thousand feet in five miles, so rapids and waterfalls characterize the stream nearly to its source. The glacier that plowed out the valley of this river must have been comparatively weak, for even with its high gradient it did not cut as deeply as the one which filled Fall river valley. The weakness of the glacier is still further shown by the number of recessional moraines between the mouth and the source of the stream. The ice river flowed to its junction with the main glacier for unknown thousands of years, in what the geologist terms a hanging valley; then as warmer years succeeded colder years it repeatedly melted back longer distances and advanced shorter distances, till it retreated to its mountain source in the ridge connecting Mount Fairchild and Hague's peak, and ceased to exist as an ice river. The final retreat of this glacier may be seen to-day in a cirque, at the base of the ridge, scoured smooth by the ice.

Just in front of the last recessional moraine of this glacier, at a level five hundred feet below its summit, is Lawn lake, and back of the moraine in hollows in the rock are two or three small bodies of water termed lakes. Snow drifts lie here and there, but with no indication of flowage except in one drift high up on the sides of Mount Fairchild. This has the ribbed appearance later seen on the surface of Hallett's glacier.

Part of the ice that pushed beyond Lawn lake may have crossed over into Black canyon through a low place in the divide now occupied in part by small lakes. This will account for the weakness of Roaring river glacier in the lower part of its course. At about the place of division of Roaring river glacier the right or western arm of this ice river encountered a low mountain, and divided, passing around the mountain and uniting below it. This mountain was thus a Nunatak in a field of ice. Most of the water flows at present on the eastern side, but a small lake was seen in the western valley.

Hallett's glacier was the last objective in this August vacation. Our party, consisting of a nephew, two daughters, a minister and the writer, climbed the ridge connecting Hague's peak with Mummy mountain, from the cirque of Roaring river glacier up a slope covered so thickly with

disintegration boulders that the solid rock of the ridge was nowhere visible; and thence we descended four or five hundred feet to Hallett's glacier. The ridge has an elevation of 13,400 feet above sea level, and gave a fine view of the glacier lying in its cirque below, with its terminal moraine immediately below it. On descending to the moraine we found that it consisted of great, angular bowlders forming a terminal moraine in front of the ice, rising, like so many others in the Estes Park region, five hundred feet above the creek erosion valley below.

Apparently Hallett's glacier has never left the cirque which it has excavated on the east side of the ridge, extending north from Hague's peak, but has continuously shoved out disintegration bowlders, which it has plucked from the ridge behind it, and has thus backed into the ridge. Sometime it will back through where gaps are already visible, and the glacier will cease to exist.

On crossing the ridge connecting Mummy mountain with Hague's peak, the first view of Hallett's glacier was very fine, almost awe-inspiring. The glacier was glistening white from newly fallen snow, and, seen from a height of five hundred feet in its setting of black rock on all sides, one felt like sitting down and studying it as he would an oil painting.

Hallett's glacier is properly a *névé*, and, while it is still alive and has a crevasse where the *névé* drops from a higher to a lower level, the glacier has done little work beyond excavating its cirque and pushing out its great terminal moraine of blocks of gneiss.

The winter preceding our visit had been very stormy, and the cirque was unusually full of snow at the time of our visit in August, so we had no opportunity to visit the crevasse and get a view of the interior of the *névé*. The concave surface of the *névé* is evenly ribbed from back to front. No attempt was made to find the cause of the ribbing, but no other bodies of snow had the ribbed surface except one high up on Mount Fairchild, and it was therefore surmised that the ridges were produced by the motion of the glacier.

The mountains of the Estes Park region consist chiefly of gneiss and mica schist. Even the so-called Pillars of Hercules in Thompson canyon are but the edges of layers of fine-textured mica schist. The bowlders of all the moraines have not been moved more than fifteen miles, most of them not more than five or six. They are, therefore, still angular, like the disintegration bowlders of Hague's peak, and have not been smoothed by sliding. It may be of interest to the mineralogist to learn that many of the bowlders on the slopes of the ridge connecting Hague's peak and Mummy mountain contain twin crystals of feldspar.

Several vacations would be required for a complete study of all these morainic ridges in the vicinity of Estes Park, but such studies would take one into a region replete with gorges, snow fields and rugged mountain peaks, and would fill the hearts of the fisherman, mountain climber, teacher of physical geography, geologist and artist with the deepest pleasure.